UK governments and the British bomber-borne nuclear deterrent, 1945-1955

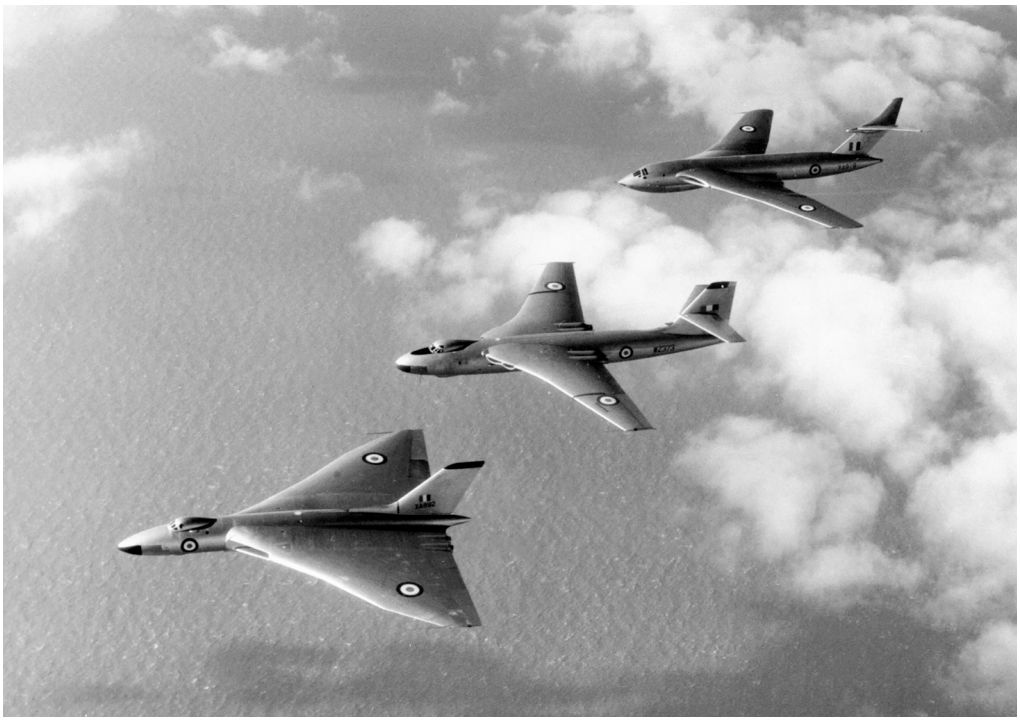
By Mr Alan Jackson

Biography: Alan Jackson completed an MA in air power at the University of Birmingham in 2016, under the tutelage of Air Commodore (Retd) Dr Peter Gray and Dr James Pugh. Alan's career was spent in industrial management. His interest in the history of air power, and in its current and future application, was sparked by early Cold War experiences. His article looks at British government decisions on the bomber-borne nuclear deterrent in those early Cold War years; it is based on his MA dissertation, for which he was awarded the Royal Air Force Museum Masters Prize in Air Power Studies for 2016/17.

Abstract: Decisions made by British governments in the period from 1945 to 1955 led to the creation of an advanced strategic bombing force to deliver a British independent nuclear deterrent. During the same period, proposals were made to extend the life of the 'V-Force' and find its eventual replacement. The reasoning behind those decisions, and the extent to which they can be explained and justified in terms of political objectives, economic capacity, and technical advance, are the subject of this article. The author identifies that, whilst the creation of the V-Force was a very significant achievement, by 1955 serious questions had already arisen as to its potential operational effectiveness.

Introduction

The grand strategic decision to create an independent British nuclear deterrent, the decision which was fundamental to the creation of the British V-bomber force, has often been characterised as flowing from the desire to maintain Britain's great power status.[1] Kenneth Morgan pointed to the readiness of Labour to support a foreign policy which was in many areas 'virtually indistinguishable from those of Conservative or imperialist administrations in the past'; he remarked how little disagreement there was in the parliamentary Labour Party.[2] Alan Bullock emphasised that Labour ministers who had been in the wartime coalition, and particularly Attlee and Bevin, had been significant contributors to what was genuinely a shared policy for the 'post-war international settlement'; their experience had been gained in government, 'with all the resources of government, including a mass of secret information, and with their minds focused on the national interest in a world dominated by power politics'.[3] Peter Hennessy commented that indeed 'Britain was a superpower in 1945, as it had been in the nineteenth century, for a single simple reason: its possession of a global Empire'.[4] Bevin, he said, 'was not one to relinquish voluntarily one ounce of British power.'[5] Morgan pointed also to the long shadow of 1930s appeasement; 'a powerful factor throughout the post-1945 period was the belief that Labour must not lapse again into the quasi-pacifist illusions of the 'appeasement' era'.[6] Thus defence, and how to afford it, was an important policy issue for



RAF V-bombers in flight – Avro Vulcan, Vickers Valiant and Handley-Page Victor © IWM GOV 9361

the incoming government, which faced all the problems of giving effect to its social and industrial aims while converting from a war to a peace economy.

With the passing in 1946 in the United States of the Atomic Energy Act (the McMahon Act), and the consequent ending of co-operation on development of nuclear weapons, the British government had to decide whether to embark independently on the creation of a nuclear deterrent. Richard Rosecrance wrote that 'there was absolutely no question at the end of the war that Britain would go ahead with the atomic bomb'.[7] Hennessy said that 'Attlee never agonised over atomic matters'.[8] In his official biography of Attlee, Kenneth Harris commented that the international situation faced by the British government early in 1947 saw to the east the Soviets 'strongly entrenched in Europe', and to the west the forthcoming 1948 American presidential election which might have seen the election of 'an isolationist Republican'; 'Britain could not have resisted the Russian advance [across Europe] with conventional weapons'.[9] As John Bew said, the fear was that if America failed to defend Europe, and Russia got the bomb first, Britain could be left alone.[10] In this context, the decision to proceed with a British bomb, and consequently with a delivery system for it, was unsurprising.

The desire to create a British nuclear deterrent had to be reconciled with Britain's economic position at the end of the Second World War. The state of Britain's economy then, and the scale of her defence commitments, has perhaps not been better and more succinctly described than by Margaret Gowing in the official history of the British atomic energy project:

> Britain had, in winning the war, sold a substantial proportion of her foreign investments, run down her gold and dollar reserves and incurred a mountain of debt, while a third of her merchant fleet lay at the bottom of the sea, and exports were a third of the pre-war level… Yet defence commitments in a war-torn world were still very heavy.[11]

Much of what has been written about the economics of the period focuses on the impact of defence expenditure on the British economy overall; the literature has little to say about the decision to proceed with an independent deterrent in the context of governments' other priorities.[12]

In terms of the translation of policy to hardware, Wynn observed that the only foreseeable delivery system for the atomic bomb to inland targets over any distance in 1945 was the aeroplane, and that this was expected to be true for the next ten years.[13] That expectation was to prove approximately correct.[14] By 1955, supersonic flight by military aircraft was a reality. In Britain the English Electric P1 had its first flight in July 1954, and exceeded Mach 1 in level flight for the first time less than a month later.[15] Work began in 1955 on a 100-mile range Mach 2 stand-off nuclear weapon, to be carried by the V-bombers, as a counter to expected developments in Soviet air defences.[16] Research was already ongoing into the feasibility of a supersonic bomber to succeed the V-force.[17] Significantly, but ultimately abortively, work had

also begun on the proposed medium-range ballistic missile, Blue Streak.[18] The period was one of high technological ambition.

The political and economic context

Labour's victory in the general election of July 1945 with a large majority provided Clement Attlee's government with a strong mandate to carry its policies through.[19] These policies were focused on measures intended to 'win the peace':

> 'The Labour Party makes no baseless promises. The future will not be easy. But this time the peace must be won. The Labour Party offers the nation a plan which will win the Peace for the People'.[20]

This offered the voter a deliberate contrast with what Labour saw as the failure after the First World War to produce a better life for the people of Britain. In 1919, 'the "hard-faced men who had done so well out of the war" were able to get the kind of peace that suited themselves'. The peace now must be prosperous for all. The Labour programme set out to achieve this by proposing measures in six areas: 'jobs for all'; 'industry in the service of the nation'; 'housing and the building programme'; 'education and recreation'; 'health of the nation and its children'; and 'social insurance against the rainy day'. These measures defined the objectives of the Attlee government; but Labour did not ignore defence. In a newsreel election address, Attlee began with the words: 'Labour puts first things first: security from war. . .'.[21]

The economic situation faced by the government in August 1945 was dire. Attlee summarised it in his 1954 memoir:

> Our whole economy had been geared to the war effort. We had allowed our export trade to decline. We were closely integrated with the United States economy through the operation of Lend/Lease and this had meant that we had not had to worry about our supplies of food and raw materials nor about our overseas payments. Now, in a moment, all this was brought to an end. I do not know whether President Truman could have continued Lend/Lease for a reasonable period in order to give us time for redeploying our industry, but in fact he did not. I doubt if the American Administration realised how serious was the blow they had struck.[22]

Truman cancelled Lend/Lease eight days after the Japanese surrender.[23] Keynes had recently warned the cabinet that Britain faced 'a financial Dunkirk'.[24] This could only be avoided by expanding exports, cutting overseas expenditure, and obtaining financial aid from the United States; these required actions often at odds with defence needs.

Britain's government debt problem at the end of the Second World War was extreme. By 1946/47 it had reached 240% of gross domestic product (GDP), despite continuing GDP growth.[25] By contrast, UK government net debt is currently running at about 86% of

GDP.[26] Government expenditure had risen during the Second World War to extreme levels, extensively financed by borrowing; it peaked at 70% of GDP in 1945; of that total, 52% of GDP was accounted for by defence spending. In the fifteen years to 1939, total government spending had only briefly risen above 30% of GDP; defence spending in that period averaged 2.9%, a level to which it would not fall again until 1997. During the period 1945-1955, defence spending averaged 16.7% of GDP; omitting the years 1945 to 1947, when spending was influenced by the gradual transition from a war economy to peace, the average was 8.9%.[27] This high level was influenced both by rearmament with modern weapons, including development of the V-force, and by Korean War costs. In real terms, defence spending almost doubled between 1950 and 1953.[28]

Despite the country's financial problems, Labour's objective to 'win the peace' for the people met with considerable success. From 1948 to 1951, defence expenditure totalled at 2005 prices £99.1bn. This compared with a total for government spending in the four years on pensions, health, education and welfare of £158.7bn, a 72% increase over the four peacetime years of 1933 to 1936.[29] The building of public housing also advanced. From 1948 to 1951, public housing completions totalled 593,530; this compared with 205,751 from 1933 to 1936.[30] All this had been achieved whilst almost achieving balanced external trade by 1950; though the rearmament triggered by the Korean War put paid to that.[31]

Politics and nuclear deterrence

Whilst concern was voiced over the impact on Britain's economic position of the decision to create a British nuclear deterrent, it appears to have carried little weight with Attlee. As he said in his autobiography, he 'was not prepared to leave Britain fully dependent in this sphere on our friends across the Atlantic.'[32] Pressures in early post-war years for international control of atomic energy were rejected on the grounds that they 'would only be observed as long as it suited the convenience of those who were a party to them'.[33] The need for the production of fissile materials for nuclear weapons was signalled as early as December 1945, when the construction of a plutonium production pile was agreed at a meeting of GEN75, the cabinet committee charged with assessing Britain's nuclear energy requirements.[34] At the same meeting the Chiefs of Staff were asked to submit a report on 'our requirements for atomic bombs and the possibility of making consequential reductions in other forms of armaments production'.

Here in 1945 was an early and important hint that nuclear deterrence was seen as a means of reducing the cost of conventional defences. In 1952 the United States' Joint Chiefs of Staff would accuse Britain of promoting the nuclear deterrence strategy as a means of avoiding its conventional force obligations.[35] The British Chiefs of Staff regarded the conventional force alternative to nuclear deterrence, based on the 1914/18 model of a long war in Europe, as 'an economic impossibility, a logistic nightmare and a strategic nonsense'.[36] The American objection to the British approach proved short-lived; in 1953 the Eisenhower administration's 'New Look' policy marked its acceptance that a nuclear strategy would allow a reduction in the cost of manpower.[37] British strategy certainly saw a great reduction in British forces' manpower;

at 878,000 in 1952, the total had halved by 1963, the point at which the V-force had reached maximum strength and conscription had ceased.[38]

Economic concern over the nuclear programme expressed at GEN75 meetings came to a head at an October 1946 meeting. The influence of the Chancellor of the Exchequer (Dalton) and President of the Board of Trade (Cripps) in GEN75 is clear:

> In discussion it was urged that we must consider seriously whether we could afford to divert from civilian consumption and the restoration of our balance of payments, the economic resources required for a project on this scale.[39]

Foreign Secretary Bevin's response was unequivocal:

> That won't do at all… we've got to have this… I don't mind for myself, but I don't want any other Foreign Secretary of this country to be talked to or at by a Secretary of State in the United States as I have just had in my discussions with Mr Byrnes. We've got to have this thing over here whatever it costs… We've got to have the bloody Union Jack on top of it.[40]

Attlee subsequently established the GEN163 committee, to decide whether to proceed with a British bomb. The committee met once, on 8 January 1947.[41] Chaired by the Prime Minister, Dalton and Cripps were not present. This at a time when ministers were engrossed with economic conditions and, as Gowing observed, 'Britain was almost at her darkest economic hour with factories closing down for lack of coal' during the worst winter for 200 years.[42] Having considered a report by Lord Portal, the committee decided 'that research and development work on atomic weapons should be undertaken'.[43] Requiring the utmost secrecy, only three copies of the confidential minutes were to be retained.[44] The atomic path had been chosen, and with it the need for a force of advanced bombers.

The development of defence policy

The development of defence policy in the ten years following the end of the Second World War, and the emphasis on nuclear deterrence, had a public and a secret existence. The public face is summarised in annual statements relating to defence. The atomic bomb was first mentioned in 1946, but only as a matter to be dealt with in future.[45] The following year's white paper, published shortly after the GEN163 decision, referred to the supreme need to prevent war by deterring aggression.[46] In 1948 there was still no mention of the bomb or bombers.[47] There was however in May a low-key announcement that atomic weapons 'are being developed.'[48] The first public mention of new bombers came in a statement by the prime minister in January 1951 that 'the first order is being placed for a four-engined jet bomber'.[49] No explicit link was made between this development and the atomic bomb programme.

Following Labour's defeat in October 1951, the incoming Conservative government at first said little publicly. Although the 1953 white paper referred both to the bomb and bombers, it was

not until 1954 that the emphasis was first on the Communist threat to world peace; the three principal aims of defence policy were:[50]

> First, we must maintain our resistance to World Communism and to Communist adventures.... Secondly, we must, with our allies, build up the most effective possible deterrent against a major aggression which would lead to global war. Thirdly, we must do all we can, *within the limits of our resources*, to be prepared to meet such an aggression should our efforts to prevent it fail.[51]

The principal means of deterrence and of meeting aggression in the event of failure was clearly set out: 'the primary deterrent however, remains the atomic bomb…. We intend as soon as possible to build up in the Royal Air Force a force of modern bombers capable of using the atomic weapon to the fullest effect. A strong and efficient force of medium bombers is of the greatest importance.'[52] Here finally was an explicit reference to the creation of a British bomber-borne nuclear deterrent.

Matters had advanced more quickly behind the veil of secrecy. Concerns about the Soviet threat post-war had grown from late-1943 onwards.[53] By May 1947 the advice of the Chiefs of Staff was clear. Their report,"Future Defence Policy", was unambiguous: 'The issue which cannot be avoided is that our Defence Policy must at present be based on the possibility of war with Russia.'[54] Having first set out Russian strengths, the Chiefs stated that the balance against Russia must be redressed by 'increasing and exploiting our present scientific lead. This applies particularly to the development of mass destruction weapons.'[55] To prevent Russia from using weapons of mass destruction in future it would be necessary, by 1956-57, to face her with the threat of British 'use of weapons of mass destruction on a considerable scale from the outset'.[56] The report set out the factors underlying that timetable:

> All our intelligence sources indicate that Russia is striving, with German help, to improve her military potential;… We must expect that from 1956-57 Russia will probably be in a position to use some atomic bombs and biological warfare; that she may have developed … rockets, pilotless aircraft, a strategic bomber force and a submarine force; and that she will continue to maintain very large land forces…[57]

Three months later, the Joint Intelligence Committee (JIC) estimated that 'by January 1952, the Soviet Union's stock of bombs is unlikely to exceed 5,… By the end of 1956 the stock may be from 40-60'; it was 'estimated that some 30-120 atomic bombs accurately delivered … might cause the collapse of the United Kingdom without invasion'.[58] At their conference with the Chiefs of Staff in June to consider the May report, Attlee and Bevin were concerned that pursuing a policy which Russia would see as aimed at her might precipitate war. The Chiefs' advice was however accepted, subject to no reference being made to Russia in the proposals for the future size and shape of the armed forces.[59] It was from this point that the concept of nuclear deterrence of Soviet aggression became a principal pillar of UK defence policy. By 1948,

the JIC advised that 'the fundamental aim of Soviet leaders is to hasten the elimination of capitalism from all parts of the world and to replace it with their own form of communism'; this would be effected by 'revolutionary struggle', 'assisted, should favourable conditions arise, by military action on the part of Soviet and satellite armed forces.'[60]

Further papers by the Chiefs on global strategy were prepared in 1950 and 1952. The 1950 paper emphasised the essentially global nature of the Cold War, and the imperative of a joint strategy with the United States, the British Commonwealth and the Western European nations.[61] It noted 'the discovery by Russia of the atomic bomb', and pointed to current Western weakness; 'from the purely military point of view, Russia could march to the Atlantic at any moment.'[62] Richard Aldrich suggested that intelligence reports of Russia's first bomb test in August 1949 'were one of the key factors that triggered the recasting of British strategy in the period 1950-52'.[63] Research and development of nuclear weapons was a high priority.[64] The 1952 Global Strategy Paper (GSP), described by Baylis as forming 'a focal point for all strategic deliberations for the next five years', emphasised the need for a co-ordinated allied strategy; and that deterrence could only be achieved by 'the knowledge on the part of the Kremlin that any aggression on their part will involve immediate and crushing retaliation… with the atomic weapon'.[65] Economic pressures required a reduction in planned defence expenditure generally, and to the bomber expansion programme in particular.[66] Among the Chiefs' conclusions was that 'it would be wrong for the United Kingdom to take no part in the Atomic Air Offensive. To achieve this while meeting economic demands, the expansion programme of the Royal Air Force should be revised to include a larger proportion of four-engined medium jet-bombers, at the expense of aircraft for tactical use.'[67] The paper was approved by the Cabinet with few significant changes.[68]

In 1953, the RAF continued to emphasise the centrality of the medium-range bomber force. In January, the Deputy Chief of the Air Staff (DCAS), in a minute to the Secretary of State for Air stressing its importance, emphasised the primacy of its deterrent role, but if war came it must 'strike as powerful an initial blow as possible… For deterrence the biggest force we can afford is the least we should provide.'[69] The Vice Chief of the Air Staff (VCAS) declared that 'the primary offensive agent of air power is the strategic bomber'. Reflecting that the first few days in a nuclear war would be critical to the UK's survival, the VCAS made clear that 'this offensive element of our defence [must be] immediately available – and it must be under our own control.'[70]

Continuing economic problems in 1952 had led Churchill to establish a sub-committee of ministers at the beginning of 1953, whose task was to conduct a 'radical review of the focus of the defence effort after 1954', and from which the Chiefs of Staff were excluded.[71] There was relentless pressure from the Treasury to reduce defence costs.[72] This was a factor in the sub-committee's decision that the services should be instructed to plan for a war of only six weeks.[73] As Baylis wrote, this focused the military emphasis yet further on the nuclear deterrent.[74] Economic pressure continued to bear down on the military's capacity to deliver

policy objectives. A suggestion during the 1954 defence programme review, that reductions in the V-bomber force might be used to fund increases in Fighter Command's strength, was strongly resisted by the VCAS.[75] Looking ahead in 1954 to force sizes in the period 1958-1960, the Air Ministry assumed that strategic policy would remain 'to rely on our strength in nuclear weapons to establish our influence in the world, and, in conjunction with the United States, to blunt the enemy offensive if war comes.'[76]

It is important to recognise that the strategy of bomber-borne deterrence was widely approved. Within the armed forces, Field Marshal Slim, Chief of the Imperial General Staff, and Admiral McGrigor, First Sea Lord, were with Slessor co-signatories of the GSP. Slessor and Slim had agreed to naval demands to cover the requirements for a period of 'broken-backed hostilities' at sea following an initial nuclear exchange; however, McGrigor later accepted that the GSP had recommended 'that preparations for war should be primarily directed to the requirements of the first few intense weeks, little provision being made for more long-term requirements.'[77] The strategy had cross-party support in Parliament. In closing the debate for the Opposition on the 1954 Statement on Defence, Attlee re-confirmed Labour's position. It did not force a division on the statement as a whole.[78] Attlee emphasised the deterrent strategy:

> Our great hope is that the horror of the atomic weapon will be so great that it will lead to its never being used. I do not see much point in speculating upon broken-back warfare. If that war breaks out, both combatants will be ruined. It will be difficult to live, let alone fight.[79]

Given the incessant economic pressure on the defence budget, it is instructive to attempt to assess the cost of the nuclear deterrent and its relationship to both total defence costs and other major government programmes. Establishing the basic figures with clarity is difficult, given the obscure nature of government accounting. An October 1953 note from the AUS(A) to the CAS estimated the cost of the RAF, by operational command, over the three year period 1953/54 to 1956/57; it provided a precise-looking cost for Bomber Command of £505m, 24% of the RAF total, for the period.[80] However, Bomber Command would comprise more than just the strategic nuclear strike force during this period; and, as the note goes on to say, the cost of the radar stations was mainly attributed to Fighter Command, a significant part of whose task was to defend the bomber bases. Additionally, the allocation of training, maintenance and overhead costs was 'necessarily arbitrary'.

The unreliable nature of the data means that any attempt to put the cost of the nuclear deterrent into a wider context will be flawed. It does however provide some sense of scale. Gowing gave figures for the nuclear project itself, subject to caveats, of capital expenditure for the period 1946 to 1953 of £72m, and current expenditure in the same period of £66.7m.[81] If the annual rate for the period 1953 to 1957 implied by AUS(A)'s £505m figure is accepted as a basis for the earlier period, the implied average total annual cost for 1946 to 1953 for the

deterrent was £144m.[82] This represented 2.2% of total government expenditure in 1953, 7.6% of total defence spending, and 7.3% of the total spent on healthcare, pensions, education and welfare.[83] The costs were significant, but their scale, at a time when government and public were alarmed by the magnitude of the Soviet threat, appears proportionate.

From policy to hardware

Successful deterrence promised the prevention of war, not its successful prosecution. But what if deterrence failed? The threat of retaliation had to be real. The bombers had to have targets of real military value which they could reach. In terms of what would actually be required of the future V-force, and consequently its design parameters, the period after the return of a Conservative government to power in 1951 was significant.[84] In his role as CAS, Sir John Slessor made arguably the greatest individual contribution to the creation of the V-force during this period.[85] He influenced strongly both deterrent strategy generally, and the targeting policy adopted. In a December 1950 note to the Chiefs of Staff Committee, he had said that '"the effective modern bomber force" which is needed … [must possess] the performance, range, accuracy and hitting power that will enable them to attack successfully'. In order 'to hold the enemy as far to the East as possible', targets would include airfields, expected to be those used for attacks against the UK, guided weapons sites, supply centres and possibly large troop concentrations. In this context, 'most important of all, we must clearly have a bomber capable of carrying and delivering the A. bomb…'[86] As Ball wrote, by means of the GSP, Slessor 'put the bomber at the centre of British strategy' and this was seen as 'a triumph for the RAF'.[87] Among the conclusions of the GSP was that there was no foreseeable defence against atomic air attack.[88] The deterrent would be effective provided 'that the intention of the Allies *to use the atom bomb immediately* is unmistakably clear to the Russians'.[89] Slessor had made clear earlier to the Secretary of State for Air what he meant by this immediate use of the bomb if the deterrent failed to deter the Russians:

> if it [a Russian invasion of Western Europe] came, I do not believe the Red Army could be stopped by the Divisions and Tactical Air Forces which N.A.T.O. can in fact build-up without busting Europe and U.K. economically – which may well be the Russian game. I believe the only really sound course would be to build up a completely overwhelming British/American bomber force with the A bomb, capable of pulverizing Russia itself *and eliminating the Red Air Force at its bases*.[90]

This identification by Slessor of the British bomb as 'the best counter-air weapon in existence' became an important factor in target selection.[91]

Although Russia had dispersed much manufacturing capacity to the east during the Second World War, many potential targets, including many Soviet cities, lay west of the Urals.[92] The great circle distance from the bomber bases of Lincolnshire and East Anglia to Moscow, for example, is somewhat less than 1,300 nautical miles. For a hypothetical attack on Russia, the actual route would have been rather longer, as the approach (at least in later years) was

over southern Norway.[93] The Joint Intelligence Bureau (JIB), established in June 1946 from wartime departments, played an important part in the assembly of targeting information for the medium bomber force. It was charged with the collection of topographic, economic, industrial and scientific intelligence, and later of atomic intelligence.[94] It decided in December 1945 'to prepare target intelligence surveys'.[95] Some of its output can be seen in a document comparing the operational value of the V-bombers, produced in January 1953; in it the DCAS set out a list, based on a study by the JIB in May 1952, of 'possible strategic target systems'. These included airfields 'considered to be most suitable for use as medium bomber bases', as well as administrative and industrial targets.[96] All of the airfield targets, and a significant proportion of the administrative and industrial targets, lay less than 1,500 nautical miles from the UK. The range requirement which had earlier emerged in the specifications which led to the creation of the V-force aligned with this targeting scheme.

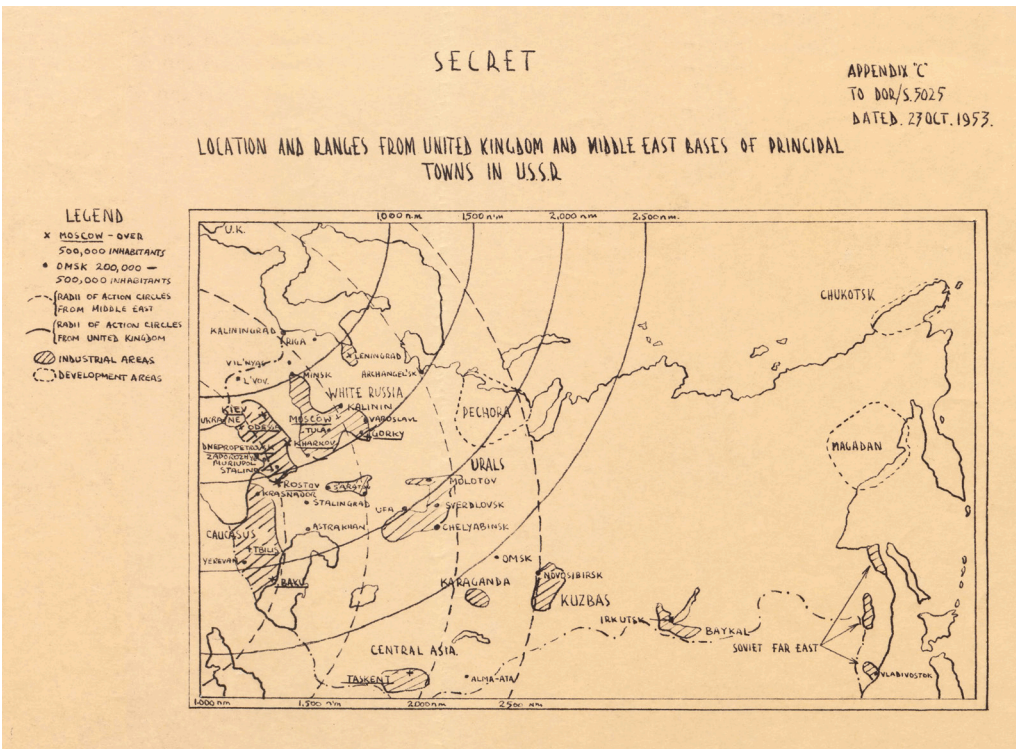


Figure 1: Distances of Soviet cities from UK and Middle East Bases. TNA AIR 20/8575 Crown copyright (OGL).

The practical steps to translate strategy into the required hardware first to deter, and if that failed, to provide the capability to deliver atomic bombs to their targets in an act of 'immediate and crushing retaliation', began earlier than the GSP, with the issue by the Air Staff in August 1946 of an operational requirement (OR1001) for the bomb itself.[97] This was five months before the GEN163 decision to proceed with development, but after the Cabinet Defence Committee

accepted on 22 July 1946 the need to plan for the adoption of both atomic weapons and the bombers needed to deliver them.[98] The size of the bomb, uncertain at first, was among the defining criteria of the atomic bombers.

Thinking about next generation bombers had begun much earlier. The Secretary of State for Air, Archibald Sinclair, emphasised as early as November 1943 that 'we need a big new bomber. We cannot afford to be left behind by America or perhaps Russia'.[99] Discussions in 1944 on future bomber policy centred on an armed heavy bomber, with an operating altitude of 35,000 feet at 350mph.[100] In July 1944, unhappy with these modest performance aspirations, the CAS pressed ACAS(TR) to follow up his desire for 'the exploitation of ceiling'.[101] ACAS(TR)'s response to Portal's minute bears a hand-written annotation by the CAS; 'Certainly, but I hope you go for 60,000 feet!'[102] The idea of the fast, high-flying strategic bomber seems first to have been expressed at the highest level at this time.

The development of these late-war ideas about future bomber capability, culminating in the technically unambitious Short Sperrin to specification B14/46, provides the background to what became the V-bomber programme.[103] The carriage of the British nuclear deterrent by bomber aircraft, rather than any other method, was firmly established during the tenure of Lord Tedder, the first post-war CAS. In November 1946 the Air Staff issued a draft operational requirement (OR230) which transformed earlier performance expectations: the next generation must carry a 10,000lb 'special bomb' (the atomic bomb) at 500kts and 50,000ft to a target 2,000 miles away from a base anywhere in the world; and would rely on speed, height, manoeuvrability, early warning devices and radar countermeasures for defence, rather than conventional armaments.[104] Research had shown that defensive armament would not be required if '500 knots could be achieved at high altitude', and indeed would be ineffective against modern rocket-firing fighters.[105] At the same time a draft requirement was issued for a 'medium range' bomber, OR229, with a less demanding range requirement.

The difficulties presented in meeting even the medium range bomber requirements were manifold, not least designing the aircraft in the absence of detailed design of the 'special bomb' that it was to carry while achieving the 100,000lb all-up weight requirement. Of that total, the Director of Technical Development noted that the fuel required to meet the range specification would weigh about 47,000lbs, and military equipment including the bomb would weigh 20,000lbs. The problem with all-up weight above 100,000lbs was the need to restrict operations only to those few airfields with suitable runways.[106] In practice the requirements set out in OR230 'were found to be unacceptable at the time'.[107] The decision was for the medium range bomber, for which specification B35/46 was issued by the Ministry of Supply (MoS) in January 1947.[108] It called for an aircraft to meet OR229 with an operational radius of 1,500nm; this put Moscow within range of eastern England.[109]

Responses to the B35/46 specification were received from six manufacturers; Armstrong Whitworth, English Electric, Handley Page, Avro, Short Brothers, and Vickers-Armstrongs.[110]

The Avro 698 (later named Vulcan) and HP80 (later, Victor) designs, with their greater degrees of wing sweepback, were described as 'advanced' relative to the English Electric and Vickers designs, which were rejected, as were those of Armstrong Whitworth and Short Brothers.[111] Contracts were issued to Handley Page for two prototypes of the HP80 on 19 November 1947, and to Avro for two prototypes of the 698 in January 1948.[112]

Development of the Sperrin ceased in October 1949, its shortcomings having been recognised, and B14/46 was cancelled.[113] There remained concern about the capability gap which would result from the long time-frame for the Avro and Handley Page developments. This gave rise to a new specification, B9/48, which had lower speed, climb rate and ceiling requirements, but with the same range and bomb load as the B35/46.[114] Vickers submitted the successful bid. This left three live projects for the medium range bomber requirement: Avro's type 698 and Handley Page's HP80 to the B35/46 specification, and Vickers' type 660 to B9/48. All three were to see service.

Three designs?

Viewed from the perspective of the incoming CAS in 1950, Sir John Slessor, the decision to proceed with all three V-bomber designs seems straightforward. The only commitments made were for two prototypes of each of the designs, and in the case of the B35/46 aircraft, small-scale aerodynamic test models.[115] Slessor emphasised the need to expedite the B9/48 aircraft to create '"the effective modern bomber force" which we do not at present possess'.[116] The argument for putting the Valiant into production as soon as possible was accepted by the Chiefs of Staff Committee at their meeting on 28 December 1950, and approved by the Minister of Defence.[117] A production order was placed in February 1951, about three months before the prototype's first flight.[118] The first production aircraft was released to (limited) service in January 1955, having first flown in December 1953.[119] The RAF had to wait until mid-1956 for the release to service of the Vulcan, and a year later for the Victor – two months before the last Valiant was delivered.[120] All nine Valiant squadrons were formed by April 1957, before the first Vulcan squadron; it was not until April 1961 that a total of nine squadrons of Victors and Vulcans had been formed.[121] Given the overriding strategic requirement to establish the British deterrent, the decision to proceed with the interim B9/48 appears justified.

Failure to choose between the two B35/46 types is less easily understood. The first flight of a Vulcan prototype took place on 30 August 1952, and of a Victor prototype on 24 December.[122] Production orders were placed before the first flight of either.[123] Surprisingly, at a meeting at the Air Ministry in May at which both the Secretary of State for Air and the Minister of Supply were present, the fact that buying some of each type would be more expensive than selecting one of the two B35 aircraft plus Valiant, or an all-Valiant force, was dismissed. 'In relation to the total expense of a sizeable medium-bomber force this extra expense was unlikely to be significant'.[124] That seems improbable; certainly the Treasury was critical at the time, and agreed to proceed only on the basis that Canberra orders would be reduced.[125] During the radical

review, the Air Staff fought to continue with all three types, pointing out both the need for the earlier in-service date of the Valiant, and the very early stage of development and great development potential of both Vulcan and Victor.[126] The initial judgement that because of their advanced designs it would be necessary to test both before making a choice appears to have stood up at this point, and memories of the failings of the Short Stirling and the Avro Manchester in the Second World War will have been fresher in the minds of the Royal Air Force leadership then than now.[127]

The Chancellor remained unimpressed, challenging in February 1953 a proposed follow-on order for the Valiant.[128] The matter went to the Prime Minister, who sided with the Air Ministry; Butler conceded the point, but the Treasury continued to press for cost savings.[129] In January 1954 the Minister of Supply (Sandys) opined that 'it will be a long while yet before we have sufficient flying experience to enable us to make this choice with any confidence.'[130] In May the CAS (now Sir William Dickson) said that 'we are likely to be well committed to both of them well before sufficient data can be available.'[131] As late as October 1955 the Air Ministry told the Treasury that 'it is not yet possible to make any decision as between the Victor and the Vulcan on operational grounds'; there was 'so little to choose between the two'.[132] If there was indeed little to choose, then the choice of one over the other should have been possible based on other criteria; on cost, for example, and the capabilities of the respective manufacturers. Ordering of both types had continued in the interim, and as Brookes said, it is clear from the ordering pattern that the option of choosing between the Vulcan and the Victor had gone by the end of 1955.[133]

It is difficult to find any convincing reason in the archives for the failure to make that choice, other perhaps than a failure of the MoS or the Treasury to insist that a choice be made. The maintenance of a significant aircraft industry may have been a factor. It may have been simple inertia, with all parties too deeply committed with orders for both types to pull back. Perhaps it was the thought that the failure of a type selected as the sole atomic bomber, such as happened later to the Valiant, would have destroyed the British deterrent. Air Force history suggests a long-standing historical tendency to hedge bets, arguably going back to April 1917 and seen again in the Second World War with the production of the Stirling, Lancaster and Halifax.[134] Slessor and Sandys agreed that any attempt to select between the V-bombers before all three had been tested would have been unwise.[135] Hindsight confirms that it was fortunate that a proposal by the Secretary of State for Air in January 1954, that the Vulcan and Victor should be sacrificed in favour of a faster build-up of Valiants, was rejected.[136]

Technology and viability

Comparison of the performance and appearance of the V-bombers with the designs of one and two decades earlier makes obvious the advance of aeronautical technology in that period. The Handley Page Heyford, the last biplane bomber to enter service with the RAF, in 1933, had a maximum speed of 142mph. The Avro Lancaster, in service from late-1941, had a maximum

speed of 287mph. The Avro Vulcan, in service from 1956, had a maximum speed of 625mph.[137] The B35/46 designs offered by the industry in 1947 represented a move into a new world of swept wings and jet engines. As Sir John Slessor reflected in 1954, 'modern methods of control and reporting, modern computers and the proximity fuse in AA artillery have put an end to the great fleets of relatively slow bombers operating at modest altitudes of the last war. . .'.[138] The V-force was expected to reach its targets defended by only height, speed, manoeuvrability and electronic countermeasures (ECM).

Late in the Second World War, government had considered how technological change might affect the performance of war. In its June 1945 report on "Future Development in Weapons and Methods of War", Sir Henry Tizard's committee, while foreseeing the possibility that missiles might eventually take over, believed that 'there will be a period, before the problems of supersonic flight are mastered, when the bomber will enjoy a maximum degree of immunity.'[139] Rockets might be used for distances of up to about 400 miles, but further than that 'we can imagine no method by which a sufficient accuracy could be obtained at these ranges [2,000 miles] to justify the effort'.[140] Not everyone agreed that bombers were, or would remain, the right vehicle for delivering nuclear weapons to their targets. Reporting in 1945 on his observation of the Hiroshima and Nagasaki missions, Leonard Cheshire said that accurate delivery of the weapon was paramount, and that 'the only foreseeable means of doing this was by space projectile'.[141] At the time that was unattainable, but whether bombers would long enjoy immunity was contentious even before the first flight of the Valiant. Vannevar Bush wrote in 1950:

> Will these high-flying planes be so completely immune? For a time yes; but looking ahead, perhaps not. For we have to think of the time required before atom bombs in quantity are in the hands of the two belligerents. The future enemy of the high-flying bomber is the guided missile.[142]

Slessor responded publicly in 1954:

> Dr Bush suggests that even the high-flying bomber may have only a temporary lease of life. There again he is almost certainly right, but I think it will remain effective long enough to be a decisive factor in our present strategy for the West.[143]

The reality in 1946 had been that the options available to implement nuclear deterrence were few. Ball said that what lay behind the commitment of the RAF to manned bombers may have been 'a visceral preference for highly sophisticated, high performance and high cost aircraft'. Up to 1955, it is hard to see that the Air Staff had any choice.[144]

Threats to the viability of the bomber-borne deterrent had started to emerge by 1955. The MiG-17 interceptor was in service with its ceiling of more than 51,000'. Both the S-25 surface-to-air missile (SAM) system around Moscow and the supersonic MiG-19 interceptor, with its ceiling above 57,000' and rapid climb rate, were coming into service.[145]

These developments were known in the West. A CIA report dated 12 July 1955 commented on extensive modern Soviet radar coverage, strong anti-aircraft artillery forces around Moscow capable of continuous fire effective up to 45,000' in all weather conditions, and a strong suspicion of SAM defences for Moscow.[146] The presence of the extensive S-25 system surrounding Moscow, with its range of 28 miles and ceiling of 46,000ft, was confirmed by U-2 photographic reconnaissance in 1956.[147] The S-75 mobile system, with its range of 18 miles and ceiling of 65,000ft was in service in 1957.[148]

How much American knowledge of Soviet air defences was conveyed to the British is unclear, but the RAF had similar information by about the same time.[149] Even absent the relevant intelligence, the position could have been assessed by attributing to the Soviets a similar degree of technical advance to that being achieved at home. In the interceptor field, the all-weather Gloster Javelin, with its 52,000' ceiling and Fireflash missiles, entered service in 1955. The English Electric P1A, a prototype for the Lightning interceptor, had achieved M1.5 in 1954; the Lightning would go on to M2.0+ and a service ceiling above 60,000', and the F1 was in service in 1960.[150]

Concern within the RAF about the impact of improving Soviet air defences on the effectiveness of the V-force was apparent by 1954. In February, a minute from the CAS to the Secretary of State for Air, sparked by knowledge that the MiG-17 was faster than the Valiant, urged the purchase of more Vulcans and Victors because of their 'precious extra speed and height'.[151] At a November meeting of the Air Council, there was optimism about the capability of the Valiant; C-in-C Bomber Command expressed the view that 'it should be capable of penetrating the existing Russian defence system without undue difficulty.'[152] Such optimism did not last long. By July 1955, concern had begun to focus attention on steps which might be taken to improve the operational effectiveness of the V-bombers. A draft operational requirements report noted that:

> Our plans for maintaining an effective strategic deterrent with the "V" bombers has [sic] been upset by the very rapid advance made by the Russians in the development of electronic equipment, a supersonic fighter and an all weather fighter, and their outstanding ability to finalise their requirements for production.[153]

It went on to state that European Russia had complete early warning and GCI radar coverage, that the MiG-15 was rapidly being replaced by the MiG-17, and that a new all-weather fighter and single seat fighter were beginning to enter service.[154] By 1960, Soviet SAM coverage was expected to extend from the Baltic to the Caspian, with just one small gap. Recommendations in the draft report included high priority development of ECM, the introduction of a decoy missile, consideration of a low-level role for the Valiant, and urgent consideration of the feasibility of introducing 'an unmanned supersonic surface-to-surface guided weapon by 1962'. ACAS(OR) followed up immediately with a recommendation to the Air Council that efforts be made to increase the altitude capability over the target of the Vulcan

and Victor as rapidly as possible.[155]

Planned new engines, new wings and comprehensive ECM would in time improve the position, but as an October 1955 paper noted:

> even allowing for improvements resulting from these earlier plans, our most recent examinations have shown that yet more extensive developments must now be urgently considered. Intelligence information shows that the Russian defences are distinctly superior in many respects to our previous estimates.[156]

Noting that the planned supersonic reconnaissance aircraft to OR330 remained further off than previously hoped, the paper suggested that the V-force 'would be in danger of becoming less effective' from 1958 onwards. Further, that 'an entirely new system of adequate performance', then expected to be the Blue Streak intermediate-range ballistic missile, was unlikely before 1964 'and probably much later'. That entirely new system, in the form of the then-unforeseen Polaris SSBNs, was not in place until 1 July 1969.[157] The paper's recommendations to sustain the force's effectiveness included higher priority for several existing projects, including the 'powered and guided bomb' to OR1132 (Blue Steel) and the addition of a bombing role in OR330. New projects proposed for 'additional development effort in the near future' were the decoy system mentioned in the July paper; subtler ECM; significant improvements to the range of the OR1132 weapon; and finding a means to avoid the generation of condensation trails. Contrails were expected, in daytime or on moonlit nights, entirely to negate the benefits of 'our whole ECM programme'.

Low-level attack was extensively investigated. It was thought in March 1955 that targets could be reached without in-flight refuelling by flying the low-level sections (the last 650nm to and back from the target) on two engines.[158] In May 1956 it was reported to a meeting between the Air Ministry and the MoS that if the Valiant were used in low-level operations for more than 150 hours there might be fatigue failures.[159] This was unsurprising; at a meeting in November 1946, it had been noted that to achieve high speed at high altitude, it would be necessary 'to get the minimum structure weight', and that consequently 'the aircraft would not be stressed for high speeds at a low altitude'.[160]

In June 1956, a draft report suggested that all the V-bombers would be at risk by 1960.[161] The Valiant would be unable to operate at high level even at night by then. The forecast loss level was prohibitive; even using Blue Steel, an attack to a depth of 530nm in Soviet territory might be expected to result in the loss of the whole Valiant force. The V-force eventually switched to low-level attack seven years later, spurred by the deployment of the S-125 SAM system.[162] Plans for ECM were carried forward, but with uncertain success. Speaking to the RAF Historical Society in 2002, Wing Commander Rod Powell recalled his experiences as an Air Electronics Officer on Vulcans from 1966. Remarking that it is impossible to know what the survivability rate of the V-force would have been:

> My guess is that many of the aircraft would have been shot down before they reached their missile release point or, in the case of the free-fallers, the target, because, to be honest, the EW [electronic warfare] suite that we had at the time was just not good enough.[163]

He observed that all the EW equipment on the Vulcan at that time 'had been specifically designed to counter the Soviet high level threats of the 1950s but were of rather less value once the force had adopted low-level tactics.'[164]

The idea that the effectiveness of the V-force could be extended by using weapons released well away from the target held promise. OR1132 called for 'a propelled controlled missile' which could be launched 100nm from the target and would be self-guided.[165] Despite many testing failures, the resulting weapon, Blue Steel, entered service in October 1962, though it was not fully operational until 1964.[166] By then its mark two version (intended to have a range of 600nm) had been cancelled in favour of an order for the Skybolt air-launched ballistic missile, itself cancelled by America in December 1962. That cancellation led to the acquisition of Polaris, and the transfer of the strategic deterrent to the Royal Navy in 1969. When the V-force switched to low-level attack in 1963, a low-level launch version of the weapon was developed; this had a much-reduced range of 50nm.[167]

Two of the improvement projects called for in the October 1955 paper never came into service; these were the OR330 supersonic reconnaissance/bomber (the Avro 730) and the OR1139 medium range ballistic missile (Blue Streak). OR330's performance targets were extremely challenging, particularly given the required in-service date of 1962.[168] It was contentious at the time among the Air Staff; ACAS (Training) wrote to ACAS(OR) in August 1955 that 'the sooner we devote all our energies to the production of an effective weapon [an intercontinental ballistic missile]…, the sooner we can 'rest easy in our beds'…[169]
The project was cancelled in 1957 following the Sandys defence white paper that year.[170]
Blue Streak too was cancelled, in 1960, principally on the grounds that its extended launch preparation time, and the small area of the UK in which to locate the silos, would make it vulnerable to pre-emptive Soviet strikes.

Technical issues aside, arguments about the *size* of the V-force illustrate the decision-making process. Slessor indicated the size of force that he thought might be necessary in a 1950 paper.[171] While cautioning that the figures were 'highly speculative', he surmised that twelve squadrons might be needed of 8 aircraft each, a mix of B9s and B35s; together with training aircraft and war reserves, the total might be 200 aircraft. For many years, and particularly positioning the RAF for the 1953 and 1954 radical reviews, the Air Staff held out for a front-line force of 240 aircraft, using all three bomber types, making up 30 squadrons.[172] In the event there were 23 operational squadrons prior to the withdrawal of the Valiant, and subsequently 15 squadrons (not far from Slessor's 1950 estimate).[173] The overall total produced of all three V-bomber types was 330 including prototypes.[174]

Conclusions

The motivations and defence policy justifications of the grand strategic decision to create an independent British nuclear deterrent are clear. Intimate knowledge in government of how close the country had come to defeat in 1940 instilled in Attlee and Bevin (and probably in most Britons) a sense that the country and empire must be better defended in future. Russian actions in central Europe and around the world induced a real fear that, absent adequate allied conventional forces, Soviet armies could and well might roll across Europe to the English Channel; and in 1948 there was the risk of an isolationist America under a new president. The idea that Britain's status as a great power must be maintained was ingrained and a powerful motivator.

Britain's economic situation was difficult throughout the period. Despite this, much of Labour's 1945 policy platform was carried through while the country's economic position improved to some degree *and* the steps necessary to create the independent deterrent were taken. In the early 1950s Britain created the model of nuclear deterrence as a means of reducing conventional defence costs in the Cold War environment. The conventional force alternative would indeed have been 'an economic impossibility [and a] logistic nightmare' and arguably also 'a strategic nonsense.'[175]

Whether nuclear deterrence was effective is a more difficult matter; an ineffective deterrent would be no deterrent at all. Attempting to answer the question 'did the bomb deter the Soviet Union from doing things it would otherwise have done', David Holloway concluded that 'there is no convincing evidence to show that the atomic bomb deterred a Soviet invasion of Western Europe in the first four years after the [Second World] war'.[176] More positively, Holloway said that:

> Nuclear weapons did shape the way in which his [Stalin's] successors thought about East/West relations. It was the danger of nuclear war, above all, that led them to adopt the policy of peaceful coexistence.[177]

The decisions which flowed from the grand strategy as they affected the creation of the V-bomber force are more readily analysed. The original decision to proceed with the development of advanced jet bombers in 1946 appears wholly justified. In the late 1940s and early 1950s there was no practicable alternative to strategic bombers to carry the deterrent. Given the widely shared perception in Britain at the time of the risk of another total war, the creation of the V-force seems a proportionate and economically effective response.

That Sir John Slessor put the bomber at the heart of British post-war strategy is clear, and his counterforce doctrine for the use of the V-force was technically coincident with the 1946 operational requirements which gave birth to the B9 and B35 bombers. Whether that doctrine would have proved effective had the Cold War turned hot is a matter of conjecture. Slessor's doctrine for the use of the atom bomb was in any case the child of the

pre-intercontinental missile and pre-thermonuclear weapon era. Targeting policy would change following the development of the hydrogen bomb and the ICBM, as would the concept of 'winning' a nuclear war.

Decisions which saw all three V-bombers in service are open to challenge. One interpretation of the archival evidence suggests that the problem was a lack of decisive leadership in the MoS to overcome the RAF's 'visceral preference for highly sophisticated, high performance and high cost aircraft'.[178] That said, the later experience of fatigue failure in the Valiant supports the decision not to rely on one type.

Air power technology moved on apace during the period. Less than sixteen years after Portal's aspiration for the next generation of bombers to fly at 60,000', that height was proved not to have been enough by the destruction of Gary Powers' U-2; and as has been shown, the vulnerability of high flying aircraft, and by extension the V-force, to Soviet air defences had been known at least since 1954.[179] Stand-off weapons might have extended the effective life of the V-bombers, particularly had Skybolt development been completed successfully and earlier. That the V-force was particularly vulnerable during the period from 1960 to 1963 seems clear. The degree of success which might have been achieved during the low-level attack era from 1963 to 1969 is open to question. The V-bomber electronic warfare suite was reportedly unsuited to low-level operations, and only part of the force was equipped with Blue Steel. Blue Steel itself was unproven at the eventual operational release altitude of 250ft.

The Earl of Bandon's comment in 1955, at the end of the period studied here, that Britons could not 'rest easy in our beds' until the deterrent was missile-borne, indicates concern at a high level in the Air Staff about the V-force's future capability to deliver the required 'crushing retaliation' if deterrence failed.[180] The evidence suggests that the nascent V-force already had vulnerabilities in the year in which its first aircraft entered service. The Chiefs of Staff had specified in 1954 that the nuclear deterrent must be 'demonstrably effective in the eyes of the world'.[181] Whether and to what extent capability shortcomings diminished or dissolved the deterrent effect of the V-force is a question requiring further research. That said, the reality for Britain was that by 1960, to be sure of success, its nuclear deterrent required a delivery system other than aircraft.[182]

Appendix: strategic bomber timeline 1945 to 1955

1945

July 3	Tizard committee report 'Future Developments in Weapons and Methods of War'.
July 16	First atom bomb test (plutonium), Los Alamos, USA.
July 26	Labour government formed in the United Kingdom.
August 6	Hiroshima bomb.

August 9	Nagasaki bomb.
August 15	Japanese surrender.
October 10	COS recommendation to PM that Britain should produce the atomic bomb.
December 18	GEN75 recommends construction of one plutonium production pile.
1946	
January 1	COS recommendation to PM to create a stock of atom bombs.
March 5	Churchill's Fulton 'Iron Curtain' speech.
August 1	Atomic Energy Act ('McMahon Act') enacted in the USA.
August 9	OR1001 issued.
1947	
January 7	Approved OR229 issued.
January 8	GEN163 committee agrees to develop the British atomic bomb.
January 24	Specification B35/46 issued.
November 19	Intention to Proceed document sent to Handley Page for two HP80 prototypes.
1948	
January	Contract issued for two Avro type 698 prototypes.
April 16	Intention to Proceed document sent to Vickers for two type 660 prototypes.
May 12	Announcement of development of the British atomic bomb in Parliament.
May 19	Draft specification B9/48 issued.
June 24	Soviet blockade of Berlin began.
November 2	Truman elected president of the USA.
1949	
April 4	North Atlantic Treaty signed.
May 12	Soviet blockade of Berlin ended.
August 28	First Soviet atom bomb test.
October	Specification B14/46 cancelled.
1950	
February 23	UK general election; Labour returned with a much reduced majority.
March 22	First RAF Boeing B-29 Washington arrived in the UK.

April 25	Beginning of the Korean War.
August 10	First RAF Washington squadron formed.
1951	
February 9	Production contract for 25 type 660 received by Vickers.
May 18	First flight of the first prototype Vickers type 660 Valiant.
May 25	Boeing B-47 entered service with USAF.
August 10	First flight of the Short SA4 Sperrin.
October 27	Conservative government formed in the United Kingdom.
1952	
July 22	First Victor (HP80) (for 25 aircraft) and Vulcan (Avro 698) (for 25 aircraft) production contracts issued.
August 30	Avro 698 Vulcan first prototype's first flight.
October 3	First British atom bomb test.
October 31	First US thermonuclear device tested (though not a usable weapon).
November 4	Eisenhower elected president of the USA.
December 24	Handley Page HP80 Victor first prototype's first flight.
1953	
June 9	OR1139 (Blue Streak) agreed text.
July 27	Korean War armistice.
August 12	First Soviet thermonuclear test.
November 7	First production atom bombs delivered to the RAF.
1954	
March 1	First US thermonuclear weapon test.
March 31	Last RAF Washington returned to the USA.
July 26	British Cabinet approved the production of thermonuclear bombs.
August	OR330 issued for supersonic reconnaissance aircraft.
September 3	OR1132 (Blue Steel) issued by the Air Staff.
1955	
January 1	First Valiant squadron formed (138 Squadron).
January 13	Valiant B1 release for service by C(A).

April	Second production orders for 40 Vulcans and 32 Victors issued.
April 6	Churchill resigned as prime minister; succeeded by Anthony Eden.
May 9	Third production orders for 24 Vulcans and 18 Victors approved by Cabinet.
May 26	UK general election; Conservative government returned to power.
June 29	First production Boeing B-52 delivered to USAF.
August 8	OR1139 (Blue Streak) issued.
October 26	Requisition approved for initial design work on Avro 730 to OR330 issue 2.

Notes

[1] See for example Kenneth O Morgan, *Labour in Power 1945-1951* (Oxford: Oxford University Press, paperback edition 1985 [1984]) 279-280: Anne Deighton, *The Impossible Peace: Britain, the Division of Germany, and the Origins of the Cold War* (Oxford: Clarendon Press, 1990), 77.
[2] Morgan, *Labour in Power*, 278.
[3] Alan Bullock, *Ernest Bevin: Foreign Secretary 1945-1951* (London: William Heinemann Ltd, 1983), 65-66.
[4] Peter Hennessy, *Never Again: Britain 1945-1951* (London: Jonathan Cape, 1992), 91.
[5] *Ibid*, 93.
[6] Morgan, *Labour in Power*, 279.
[7] R N Rosecrance, *Defense of the Realm: British Strategy in the Nuclear Epoch* (New York NY: Columbia University Press, 1986), 36.
[8] Hennessy, *Never Again*, 270.
[9] Kenneth Harris, *Attlee* (London: George Weidenfeld & Nicolson Ltd, revised paperback edition 1995 [1982]), 289.
[10] John Bew, *Citizen Clem: A Biography of Attlee* (London: riverrun, 2016), 421.
[11] Margaret Gowing, *Independence and Deterrence: Britain and Atomic Energy, 1945-1952* (London: Macmillan, 1974), volume 1, 36.
[12] See for example David Edgerton, *Warfare State: Britain, 1920-1970* (Cambridge: Cambridge University Press, 2006). Till Geiger, *Britain and the Economic Problem of the Cold War: The Political Economy and the Economic Impact of the British Defence Effort, 1945-1955* (Aldershot: Ashgate Publishing Limited, 2004). G C Peden, *Arms, Economics and British Strategy: From Dreadnoughts to Hydrogen Bombs* (Cambridge: Cambridge University Press, digitally printed paperback edition 2009 [2007]).
[13] Humphrey Wynn, *The RAF Strategic Nuclear Deterrent Forces: Their Origins, Roles and Deployment 1946-1969, a Documentary History* (London: The Stationery Office, 1997), 10. Other authors commenting on these aspects include S J Ball, *The Bomber in British Strategy: Doctrine, Strategy, and Britain's World Role, 1945-1960* (Boulder CO: Westview Press, 1995).
[14] The first successful ICBM trials took place in 1957. As to the USA, see David K Stumpf, *Titan II:*

A History of a Cold War Missile Program (Fayetteville AK: The University of Arkansas Press, 2000), 8. As to the USSR, its first satellite was launched using the Soviet ICBM; see Julian Lindley-French, *A Chronology of European Security and Defence 1945-2007* (Oxford: Oxford University Press, 2007), 57.

[15] Stephen Ransom and Robert Fairclough, *English Electric Aircraft and their Predecessors* (London: Putnam, 1987), 226.

[16] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 186. This was to be 'Blue Steel'.

[17] Tony Buttler, *British Secret Projects: Jet Bombers Since 1949* (Hinckley: Midland Publishing, 2003), 82: this would have been the Avro 730.

[18] C N Hill, *A Vertical Empire: History of the British Rocketry Programme* (London: Imperial College Press, second edition, 2012), 93.

[19] For details of election results, see: **http://researchbriefings.parliament.uk/ResearchBriefing/Summary/RP12-43** (accessed 8.8.2016). The Labour Party's manifesto can be seen at **http://history.hanover.edu/courses/excerpts/111lab.html** (accessed 31.5.2016).

[20] The quotations in this paragraph are from the 1945 Labour Party election manifesto.

[21] The newsreel is available on the British Pathé website (**www.britishpathe.com/video**) (accessed 7.8.2016).

[22] C R Attlee, *As it Happened* (London: Odhams Press Limited, 'First Cheap Edition', no date. Originally published by William Heinemann, 1954), 174.

[23] Hennessy, *Never Again*, 94.

[24] TNA CAB 129/1, CP (45) 112, paragraph 27.

[25] UK government debt data: **http://www.ukpublicspending.co.uk/spending_chart_1920_1960UKp_16c1li011tcn_G0t**, accessed 7.8.2016. For the sources of the information on the UK Public Spending website, see **http://ukpublicspending.blogspot.co.uk/2009/04/how-we-got-spending-data.html** (accessed 7.8.2016). GDP data extracted from Samuel H. Williamson, 'What Was the U.K. GDP Then?' MeasuringWorth, 2016: accessed 8.8.2016 at **https://www.measuringworth.com/datasets/ukgdp/result.php**.

[26] Source: Office for Budget Responsibility at **http://budgetresponsibility.org.uk/#graphs**, accessed 30.3.2017.

[27] Government expenditure data are drawn from **http://www.ukpublicspending.co.uk/spending_chart_1900_2020UKk_16c1li011mcn_30t00t10t20t40t** (accessed 7.8.2016).

[28] Except as otherwise noted, the data in this paragraph are drawn from **http://www.ukpublicspending.co.uk/spending_chart_1900_2020UKk_16c1li011mcn_30t00t10t20t40t**. The validity of the defence data is confirmed by B R Mitchell, *British Historical Statistics* (Cambridge: Cambridge University Press, first paperback edition, 2011 [1988]), 594, which shows (in figures unadjusted for inflation) 1950 total defence spending at £740.7m in 1950 and £1,403.7m in 1953.

[29] The figures here are also at 2005 prices.

[30] Mitchell, *British Historical Statistics*, 392.

[31] Mitchell, *British Historical Statistics*, 872.

[32] Attlee, *As it Happened*, 189.

[33] TNA CAB 130/2, GEN75 4th meeting 11 October 1945, paragraph 1(ii). For an interesting summary of attempts at international control and the Baruch Plan, see Hugh Thomas, *Armed Truce: The Beginnings of the Cold War 1945-46* (London: Hamish Hamilton Ltd, 1986), 536-540.
[34] TNA CAB 130/2, GEN75 8th meeting.
[35] See for example Lawrence Freedman, *The Evolution of Nuclear Strategy*, third edition (Basingstoke: Palgrave Macmillan, 2003), 76; and Walter S Poole, *The Joint Chiefs of Staff and National Policy: Volume IV 1950-1952* (Washington DC: Office of Joint History, Office of the Chairman of the Joint Chiefs of Staff, 1998), 159-160.
[36] TNA AIR 20/11154, annex to COS 1467/5/8/52.
[37] Freedman, *The Evolution of Nuclear Strategy,* 76-77.
[38] Mitchell, *British Historical Statistics*, 121. As to V-force strength, see Wynn, *The RAF Strategic Nuclear Deterrent Forces*, chart between 500 and 501.
[39] TNA CAB 130/2, GEN75 15th meeting. The meeting was considering whether to proceed with the creation of a gaseous diffusion plant for the production of the Uranium isotope ^{235}U; this was the fissile component of the gun-type weapon dropped at Hiroshima. In the event Britain developed the implosion design of bomb used at Nagasaki, in which the fissile component was plutonium. The official history contains a discussion of the decision between the two types of fissile component: Gowing, *Independence and Deterrence*, volume 1 165-167. For a description of the two weapon types, see C N Hill, *An Atomic Empire: A Technical History of the Rise and Fall of the British Atomic Energy Programme* (London: Imperial College Press, 2013), 75.
[40] As recalled in 1982 by Sir Michael Perrin, a Ministry of Supply civil servant who was present at the meeting, and quoted by Peter Hennessy, *Cabinets and the Bomb* (Oxford: Oxford University Press, 2007), 48.
[41] TNA CAB 130/16.
[42] Gowing, *Independence and Deterrence*, volume 1, 182. As to the 1946/47 winter, see **http://www.metoffice.gov.uk/learning/learn-about-the-weather/weather-phenomena/case-studies/severe-winters** (accessed 13.8.2016).
[43] TNA CAB 104/285. Portal was reporting in his post-CAS role of Controller of Production (Atomic Energy).
[44] Ibid. There is a letter dated 8 January on the file from Rickett, who minuted the meeting, to Sir Edward Bridges, the Cabinet Secretary, stating that this very narrow circulation was required. Another note dated 10 January, initialled by Rickett, stating that all other copies had been destroyed, as should be the waxes from which the copies were made.
[45] Cmd 6743 *Statement Relating to Defence*, February 1946, 3.
[46] Cmd 7042 *Statement Relating to Defence*, February 1947, 12.
[47] Cmd 7327 *Statement Relating to Defence*, February 1948, 5.
[48] HC Deb 12 May 1948, vol 450 c2117.
[49] Cmd 8146 *Defence Programme: Statement made by the Prime Minister in the House of Commons on Monday, 29th January 1951*, 5. The statement primarily addressed a partial mobilisation of forces, the economic impact of increasing the state of military preparedness, and the re-introduction of a number of wartime controls.

[50] The 1953 white paper: Cmnd 8768 *Statement on Defence*, February 1953, 16. The first British atom bomb test had occurred in October 1952; the first US thermonuclear device was tested in the same month. The 1954 white paper: Cmd 9075 *Statement on Defence*, February 1954, 4-5.
[51] Cmd 9075 *Statement on Defence*, February 1954, 4; emphasis added.
[52] *Ibid*, 4-5.
[53] See for example Huw Dylan, *Defence Intelligence and the Cold War: Britain's Joint Intelligence Bureau 1945-1964* (Oxford: Oxford University Press, 2014), 40.
[54] TNA DEFE 4/4, COS (47) 102 (O), paragraph 8.
[55] *Ibid*, paragraph 11. The Chiefs were contemplating the use of biological as well as atomic weapons.
[56] *Ibid*, paragraph 30.
[57] *Ibid*, paragraph 23.
[58] TNA CAB 158/1, JIC (47) 7/2 final, 6.8.47, paragraphs 58-59, as reproduced in Peter Hennessy, *Cabinets and the Bomb* (Oxford: Oxford University Press, 2007), 65. The JIC was a subcommittee of the Chiefs of Staff Committee.
[59] TNA DEFE 4/4, COS (47) 74th Meeting, page 5. The meeting was attended by the Chiefs of Staff, the Prime Minister, the Minister of Defence, the Foreign Secretary, and Sir Henry Tizard. Tizard had been involved with defence research since the early 1930s. Involved in the development of radar, and in the early stages of Britain's 'Tube Alloys' atom bomb project, Churchill had denied him access to atomic information in the latter part of the Second World War. He became chief adviser to the Attlee government on defence research policy (Gowing, *Independence and Deterrence*, volume 1, 5).
[60] TNA CAB 158/3, JIC (48) 9 (O) Final, paragraph 4(a), reproduced in Hennessy, *Cabinets and the Bomb*, 72.
[61] TNA AIR 20/11154, COS (50) 139, 1.
[62] *Ibid*, re the Russian bomb, 1, paragraph 1; and re marching to the Atlantic, 3, paragraph 13(a).
[63] Richard J Aldrich (editor), *British Intelligence, Strategy and the Cold War, 1945-51* (Abingdon: Routledge, 1992, digitally printed edition 2005), 4.
[64] TNA AIR 20/11154, COS (50) 139, 17, priority B.III(a).
[65] John Baylis, *Ambiguity and Deterrence: British Nuclear Strategy 1945-1964* (Oxford: Oxford University Press, 1995), 133. The Global Strategy Paper: AIR 20/11154 annex to COS (52) 361, paragraph 37.
[66] TNA AIR 20/11154, COS (52) 361, 18, paragraph 72 re the UK economic problem.
[67] *Ibid*, 29, paragraph 139(u).
[68] Rosecrance, *Defence of the Realm*, 164.
[69] TNA AIR 20/7560, DCAS/1096 S.534, 30.1.1953. At this time ACM Sir Ronald Ivelaw-Chapman was DCAS.
[70] TNA AIR 20/7560. Report by the VCAS "Radical Review" – RAF Medium Bomber Policy, file reference '8A'. At this time ACM Sir John Baker was VCAS.
[71] This was the Ministerial Committee on Defence Policy. See CAB 134/809.
[72] See for example TNA AIR 8/1875; letter from R A Butler (Chancellor of the Exchequer) to

Harold Alexander (Minister of Defence), 28.7.1953.
[73] Baylis, *Ambiguity and Deterrence*, 165.
[74] *Ibid*, 166, 175.
[75] TNA AIR 20/8716, POL (AS) 4406 VCAS 1201, 25.8.54. By this time Ivelaw-Chapman had taken over as VCAS.
[76] TNA AIR 20/8716, G.412554/IB/8/54/50, 27.8.1954.
[77] As to broken-backed hostilities, Ian Clark and Nicholas J Wheeler, *The British Origins of Nuclear Strategy 1945-1955* (Oxford: Clarendon Press, 1989), 171-173. As to the later report, TNA CAB 131/12, D (52) 41, paragraph 3. The file has been digitised; accessed 9.8.2016.
[78] HC Deb 02 March 1954 vol 524, cc1125 and 1128.
[79] HC Deb 02 March 1954 vol 524, c1126.
[80] See TNA AIR 20/7560, AUS(A)/1148, 1.10.1953. AUS(A) was the assistant under-secretary of state for air.
[81] Gowing, *Independence and Deterrence*, 36-37.
[82] Total costs of the bomb for the eight years 1946-1953 inclusive ~£17.4m p.a.; annual rate for Bomber Command £505m/4 = £126.3m p.a. This gives a total of £143.7m p.a.
[83] Source: **http://www.ukpublicspending.co.uk/spending_chart_1945_1955UKb_16c1li011mcn_F0t30t10t** accessed 16.8.2016.
[84] See for example Lawrence Freedman, *The Evolution of Nuclear Strategy* (Basingstoke: Palgrave Macmillan, 3rd edition, paperback, 2005 [1981]), 74-76; Gowing, *Independence and Deterrence*, volume 1, 440-441; Bernard Brodie, *Strategy in the Missile Age* (Santa Monica CA: RAND Corporation, paperback edition 2007 [1959]), 160-172.
[85] Slessor was CAS from 1.1.50 to 31.12.52. Bill Pyke has recently drawn attention to Slessor's significance in the creation of Cold War strategy; see "Air Marshal Sir John Slessor: The Unsung British Cold War Strategist" in *Royal Air Force Air Power Review*, volume 20 number 1, Spring 2017, 66-91.
[86] TNA AIR 20/7359, COS (50) 538.
[87] Ball, *The Bomber in British Strategy*, 53.
[88] TNA AIR 20/11154, annex to COS (52) 361, page 7 paragraph 12.
[89] TNA AIR 20/11154, annex to COS (52) 361, page 10 paragraph 37. Emphasis added by the author.
[90] TNA AIR 20/8711, draft note from CAS to Secretary of State for Air, 10.3.52, paragraph 9. Emphasis added by the author.
[91] Noted by Ball, *The Bomber in British Strategy*, 58.
[92] Andrew Roberts, *The Storm of War: A New History of the Second World War* (London: Allen Lane, 2009), 182.
[93] See Roy Brocklebank, "World War III – The 1960s Version" in *The Journal of Navigation* volume 58 number 3, September 2005, 341-347.
[94] Huw Dylan, *Defence Intelligence and the Cold War: Britain's Joint Intelligence Bureau 1945-1964* (Oxford: Oxford University Press, 2014), 1-3 and 22-23.
[95] Dylan, *Defence Intelligence*, 40-41 fn14.
[96] TNA AIR 20/11154, appendix E to 'Comparative Operational Value of Medium Bombers'.

[97] As to 'immediate and crushing retaliation', see TNA AIR 20/11154, annex to COS (52) 361, 'Defence Policy and Global Strategy', 10.
[98] OR1001 is in TNA AVIA 65/1153. The minutes of the Cabinet Defence Committee meeting on 22 July are in TNA CAB 131/1, DO (46) 23rd meeting (accessed 23.8.2016); however, the relevant parts of the minutes have been withheld from the scanned file, so the source here is Wynn, *The RAF Nuclear Deterrent Forces*, 19-20.
[99] TNA AIR 20/1734, 15.11.43.
[100] For example, TNA AIR 20/1734, minutes of a meeting held on 12.4.44. The meeting was at a high level; it was chaired by the VCAS, and MAP was represented by the Controller of Research and Development (CRD) and the Director of Technical Development (DTD). Also see TNA AIR 2/5587.
[101] TNA AIR 20/1734, minute dated 26.7.44, CAS 2604, TR/16/453. Portal was CAS at the time. ACAS(TR) was the assistant chief of the air staff for technical requirements, at the time Air Commodore J D Breakey.
[102] TNA AIR 20/1734, ACAS(TR) to CAS 31.7.44 TR/16/453, CAS 2604. Portal's comment is also dated 31.7.44; interestingly, he appears first to have written 50,000 ft., and then amended it to 60,000 ft. ACAS(TR)'s minute said that 'we cannot afford to decorate our future bombers with multiple turrets.'
[103] As to the Sperrin, see for example TNA AVIA 15/2254, Rowe (DTD at MAP) to Lipscombe (head of Short's design team) and Lipscombe's 21.2.45 reply. Short's offered six- and four-engined aircraft; the four-engined design became the Sperrin: TNA AVIA 15/2254. SB.66527/C.4(a) dated 26.4.1946, "High Altitude High Speed Bomber, Project SA4, Report on an Investigation into the Practicability of a Four Engined Design of Smaller Size." Tedder was critical of the work being given to Short Brothers; see TNA AIR 8/1613, CAS to VCAS 19.9.47.
[104] TNA AIR 20/7355, C25747/45.
[105] TNA AIR 20/7355, 45542/II, page 2 paragraph 2 et seq.
[106] The discussion of the problems takes up much of TNA AIR 20/7355, 45542/II, from page 2 onwards.
[107] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 45 and 45fn.
[108] TNA AVIA 54/96, reference number 7/Aircraft/1353/RDT2(d) dated 24.1.47. B35/46 would give rise to the Avro Vulcan and Handley Page Victor; B9/48 resulted in the Vickers Valiant.
[109] The great circle distance from, for example, Lincolnshire is somewhat less than 1,300nm. The actual route would have been rather longer, as the approach (at least in later years) was over southern Norway – see Brocklebank, "World War III", 341-347.
[110] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 47. The technical brochures from English Electric, Handley Page, Short Brothers and Vickers-Armstrongs are contained in TNA AVIA 54/95 and AVIA 54/96. The Avro and Armstrong Whitworth brochures are in TNA AVIA 54/97.
[111] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 55.
[112] *Ibid*, 582-583.
[113] Re-cessation of Sperrin development: TNA AIR 20/1734, L.M./TS.6/ACAS(TR), ACAS(TR) to VCAS 14.10.49. Re-cancellation of B14/46, Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 587. The two prototypes did fly, though the first of them later than Vickers B9/48 (Ibid, 592).

[114] TNA AVIA 54/288. The file contains both the draft specification dated 19.5.48, sent to Vickers on 25.5.48, the finalised version dated 19.7.48, and various subsequent amendments.
[115] The Handley Page HP80 (hereafter referred to as the Victor) prototype contract was issued on 19 November 1947, and the Avro 698 (hereafter, Vulcan) prototype contract in January 1948. The Vickers 660 (hereafter, Valiant) 'Intention to Purchase' contract was issued on 16 April 1948. Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 582-583. The aerodynamic test model of the Victor was the 40% scale HP88 to specification E6/48, using a Supermarine Swift fuselage (see C H Barnes, *Handley Page Aircraft since 1907* (London: Putnam & Company Ltd, 1976), 496-497). For the Vulcan, it was the one-third scale Avro 707 to specification E15/48 (see A J Jackson, *Avro Aircraft since 1908* (London: Putnam & Company Ltd, new edition 1990 [1965]), 439).
[116] TNA AIR 20/7359, COS (50) 538: note from Slessor to the Chiefs of Staff committee.
[117] The relevant CoS Committee minute is at TNA AIR 20/7359, COS (50) 213th meeting. The Minister's approval was recorded in the minutes of the Joint War Production Committee meeting of 10 January 1951 at TNA 20/7359, ISAB/1/51/28.
[118] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 591.
[119] *Ibid*, 597, 599.
[120] *Ibid*, 603, 606, 607.
[121] *Ibid*, chart between pages 500 and 501. Five squadrons of Vulcans and four of Victors had formed by April 1961. It is impossible to know how much sooner Vulcans and Victors would have been available (if at all), had B9/48 not been pursued.
[122] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 594-595.
[123] *Ibid*, 595.
[124] TNA AIR 2/11443, note of a meeting to consider orders for future RAF medium range bombers, 27.5.52.
[125] TNA AIR 2/11443, R A Butler to Duncan Sandys, then Minister of Supply, 15.7.52.
[126] The radical review referred to here was of 'defence effort after 1954'. It was established by Churchill in 1953 and carried out by the Ministerial Committee on Defence Policy. See CAB 134/809.
[127] The twin-engined Manchester was seriously overweight and underpowered; see Anthony Furse, *Wilfrid Freeman: The Genius behind Allied survival and air supremacy 1939 to 1945* (Staplehurst: Spellmount, 2000), 92. The Stirling's performance was less than optimal, in part because of the Air Staff's stipulation that it should have a wing span not exceeding 100'. For an interesting discussion of the reasons for the Stirling's poor performance, and whether it related to the need to fit within the then-standard hangar width, see Sinnott, *The Royal Air Force and Aircraft Design*, 168-170.
[128] TNA AIR 2/11443. R A Butler to Lord De L'Isle and Dudley (DLD), 26.2.1953.
[129] TNA AIR 2/11443. Personal minute WSC to RAB 29.3.53; RAB to WSC 2.4.53.
[130] TNA AIR 2/11443. Personal letter Sandys to DLD 21.1.54.
[131] TNA AIR 2/11443, loose minute CAS to CA, 12.5.54.
[132] TNA AIR 2/11443, Air Ministry to Treasury, 21.10.55.
[133] Andrew Brookes, *V-Force: The History of Britain's Airborne Deterrent* (London: Jane's Publishing

Company Limited, 1982), 68.
[134] HC Deb 26 April 1917 vol 92 col 2624. The Parliamentary Secretary to the Air Board suggested that nothing could be more fatal than large scale standardisation of aircraft types.
[135] Brookes, *V-Force*, 67. Duncan Sandys' agreement is sourced in TNA AIR 41/85 to *Flight* Magazine. That is correct; quoting it as a recent statement, it appeared on page 42 of the issue of 9.1.1953, number 2294, volume LXIII. Sandys likened the decision to putting all your money on a single horse.
[136] TNA AIR 2/11443; the Secretary of State for Air's suggestion was dated 22.1.54, and the negative response is contained in a minute from the DCAS to the CAS (since 1.1.53, Sir William Dickson). As to the Valiant's premature withdrawal from service, Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 464-471.
[137] For details of the Heyford (B9/27) and Lancaster (developed from the Manchester, to P13/36) see Colin Sinnott, *The Royal Air Force and Aircraft Design 1923-1939: Air Staff Operational Requirements* (London: Routledge, paperback edition 2013 [2001]), 67 and 165-174. Performance figures are drawn from Owen Thetford, *Aircraft of the Royal Air Force since 1918* (London: Guild Publishing, eighth edition 1988, published by arrangement with Putnam): Heyford, 309; Lancaster, 68; Vulcan, 80. Advances in range, service ceiling and bomb load are equally striking.
[138] John Cotesworth Slessor, *Strategy for the West* (London: Cassell & Company Ltd, 1954), 109.
[139] TNA DEFE 9/19, COS (45) 402 (O), paragraph 61(a). Tizard chaired an ad hoc committee established by the Joint Technical Warfare Committee, to consider "Future Developments in Weapons and Methods of War". The first edition of its report was dated 16 June 1945.
[140] TNA DEFE 9/19, COS (45) 402 (O), paragraph 59.
[141] Gowing, *Independence and Deterrence*, volume 1, 209.
[142] Vannevar Bush, *Modern Arms and Free men: A Discussion of the Role of Science in Preserving Democracy* (London: William Heinemann Ltd, 1950), 134. Bush was an engineer who had led the United States' Office of Scientific Research and Development during the Second World War.
[143] Slessor, *Strategy for the West*, 109.
[144] Ball, *The Bomber in British Strategy*, 80 (as to the Air Staff's position) and 10 (as to a taste for high performance, high cost sophistication).
[145] As to the S-25 Berkut system: Steven J Zaloga, *Red SAM: The SA-2 Guideline Anti-Aircraft Missile* (Oxford: Osprey Publishing, 2007), 4. As to the MiG-17 and MiG-19, Bill Gunston, *The Osprey Encyclopedia of Russian Aircraft 1875-1995* (London: Osprey Publishing, 1995), 192-195 and 196-200.
[146] National Intelligence Estimate 11-5-55 dated 12 July 1955, accessed 20.6.2016 at **https://www.cia.gov/library/readingroom/nic-product-type/national-intelligence-estimates**.
[147] Performance of the S-25 system is drawn from the Air Power Australia website at **http://www.ausairpower.net/APA-Rus-SAM-Site-Configs-A.html#mozTocId357043** (accessed 13.4.2017). Confirmation of the presence of the S-25 system round Moscow is described in Gregory W Pedlow, Gregory W and Donald E Welzenbach, *The CIA and the U-2 Program 1954-1974* (Washington DC: Central Intelligence Agency, 1998), 103-105; and Mike Gruntman,

Intercept 1961: The Birth of Soviet Missile Defence (Reston VA: American Institute of Aeronautics and Astronautics, Inc., 2015) 63.
[148] Zaloga, *Red SAM*, 43. Later developments of the system had a maximum range of 41 miles and a ceiling of almost 100,000ft.
[149] Michael S Goodman, *The Official History of the Joint Intelligence Committee Volume 1* (Abingdon: Routledge, 2014. Goodman noted that the 'JIC's relationship with the CIA developed in the latter's favour' (215), but that by mid-1955 it had 'undoubtedly improved over the last two years' (214). As to RAF knowledge, see for example TNA AIR 20/11551, CAS to SoS, 20.2.1954, referred to below.
[150] Stephen Ransom and Robert Fairclough, *English Electric Aircraft and their Predecessors* (London: Putnam, 1987), 227, 236. M represents Mach number, the local speed of sound.
[151] TNA AIR 20/11551, minute CAS to Secretary of State for Air dated 20 February 1954 in response to minute DCAS to CAS dated 16 February 1954, referring to the 'latest version of the MIG 15', which seems likely to have been the MiG-17.
[152] TNA AIR 20/11551, Air Council Conclusions of Meeting 21 (54), held on 18 and 24.11.54.
[153] TNA AIR 20/11552, OR16(55)5, DOR/TS.5849 dated 8.7.55; page 14 paragraph 52.
[154] The all-weather fighter, NATO code Flashlight, was the Yak-25; and the single seat fighter, NATO code Farmer, was the MiG-19. It was reported that 50 Flashlights and 60 Farmers had been seen.
[155] TNA AIR 20/11552, appendix to loose minute C.60493/ACAS(OR)/9270 dated 18.7.1955. ACAS(OR) (Assistant Chief of the Air Staff (operational research)) at the time was AVM H V Satterley, a keen proponent of OR330 (see Guy Finch, *Replacing the V-Bombers: RAF Strategic Nuclear Systems Procurement and the Bureaucratic Politics of Treat*, unpublished PhD thesis submitted to the University of Wales at Aberystwyth, December 2001, 87-105).
[156] TNA AIR 20/11552, attachment to DOR/TS.3321/ACAS(OR)/474, DCAS/4276/55 dated 6.10.55. This is the source of all the quotations in this paragraph.
[157] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 630.
[158] TNA AIR 20/11552, map attached to OR16(55)1.
[159] TNA AIR 2/14578, C.75259/55, 'The Valiant in the low level bombing role', meeting held 23.5.56.
[160] TNA AVIA 15/2254, Note of a meeting held on 11.11.46, attended among others by the Controller of Supply (Aircraft), the ACAS(TR) and the Director of the Royal Aircraft Establishment.
[161] TNA AIR 2/14578, CMS.2733/55, 'Employment of the Valiant in the low level role' dated 12.6.56.
[162] Per Air Commodore Norman Bonnor in a presentation to the Royal Air Force Historical Society on 21.10.96, 'From the '60s to the '80s 'The Last Days of Airborne Analogue Computing", *Royal Air Force Historical Society Journal 17A*, 1997, 101. The Soviet S-125 SAM system had the NATO reporting name SA-3 Goa.
[163] Wing Commander Powell's presentation to the RAF Historical Society, 10.4.02, 'EW during the V-force Era', *Royal Air Force Historical Society Journal 28*, 2003, 71.
[164] *Ibid*, 71-74.

[165] Except as otherwise noted, the information in this paragraph is drawn from Wynn, *The RAF Strategic Nuclear Deterrent Forces*, chapter 13, pages 186-220; chapter 23, pages 373-402; and chapter 26, pages 449-463.
[166] Per Air Commodore Norman Bonnor in a presentation to the Royal Air Force Historical Society on 1.4.15, 'Blue Steel – The V-force's Stand-off Bomb', *Royal Air Force Historical Society Journal 62*, 2016, 36-37, there were 15 launches in 1961, most of which failed, and a further 15 in 1962 of which about half succeeded.
[167] As to the 50nm range, see Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 441. However, Powell said (*RAFHS Journal 28*, 71) that operationally Blue Steel was to be released at 25nm from the target at an altitude of 250ft.
[168] TNA AVIA 53/516 contains the specification, RB156D; this called inter alia for the ability to reach 80,000' for short periods, and a maximum cruise speed at altitude of M2.5.
[169] TNA AIR 20/7723, minute dated 22.8.55. ACAS (Training) at the time was (then Air Marshal) Percy Bernard, 5th Earl of Bandon.
[170] The cancellation letter is in TNA AVIA 53/516, dated 25.3.57. The Sandys defence review *Defence: Outline of Future Policy Cmnd 124*, paragraph 61.
[171] TNA AIR 20/7359, COS (50) 538, 21.12.1950.
[172] See for example TNA AIR 20/11154, note from the DCAS dated 27.1.53.
[173] Wynn, *The RAF Strategic Nuclear Deterrent Forces*, chart between pages 500 and 501.
[174] Ultimately 108 Valiants were built, 136 Vulcans and 86 Victors. Valiant production number: John W R Taylor (editor), *Jane's All the World's Aircraft 1960-61* (London: Samson Low, Marston & Company, Ltd., 1960), 70. Vulcan: David W Fildes, *The Avro 698 Vulcan: The Secrets Behind its Design and Development* (Barnsley: Pen & Sword Aviation, 2012), 454-455. Victor: Ball states 83 aircraft delivered, but for consistency with the Valiant and Vulcan, the 3 prototypes have been added; Ball, *The Bomber in British Strategy*, 207.
[175] TNA AIR 20/11154 annex to COS 1467/5/8/52.
[176] David Holloway, *Stalin and the Bomb: The Soviet Union and Atomic Energy 1939-1956* (New Haven CT: Yale University Press, 1994), 271.
[177] *Ibid*, 344.
[178] Ball suggested this RAF preference in *The Bomber in British Strategy*, 10.
[179] The height of Powers' aircraft when it was shot down is confirmed in Pedlow and Welzenbach, *The Central Intelligence Agency and Overhead Reconnaissance*, 176. The individual chapters of the report in largely un-redacted form are available here: **http://nsarchive.gwu.edu/search.html** (accessed 27.8.2016). The details of the Powers shoot-down are in Chapter 4 (accessed 27.8.2016). Interestingly the UK archives concerning the use of RAF pilots to fly CIA Soviet overflights, openly discussed in the CIA report, remain closed; see for example the Op KNIFE EDGE files at TNA AIR 40/2753 and AIR 40/2754.
[180] TNA AIR 20/7723, minute dated 22.8.55. Then Air Marshal Percy Bernard, 5th Earl of Bandon was ACAS(Training) at the time.
[181] TNA AIR 20/11154. The words quoted are in the summary of the Chiefs of Staff Committee report on United Kingdom defence policy circulated by ACAS(P) on 9.7.54, page 4 paragraph (c)(i), referenced VCAS 935 and ACAS(P)/4150.

[182] The RAF did operate the Thor missile system from 1959 to 1963; however, being liquid-fuelled and not protected by silos, the missiles were vulnerable to a pre-emptive strike. See Wynn, *RAF Nuclear Deterrent Forces*, 345.
[183] Dates are mainly drawn from Wynn, *The RAF Strategic Nuclear Deterrent Forces*, 576-601; others are drawn from original documents cited in the text.

Four Canberra B.2s of 21 Squadron flying in formation past rugged mountains in Aden during a month-long detachment to Cyprus and the Middle East in early 1955 alongside 27 Squadron.

Blue Steel stand-off nuclear missiles in the storage hangar at Scampton, Lincolnshire, in February 1963.
Blue Steel, built by Avro, was introduced into service by 617 Squadron in 1963. It carried a one megaton warhead and was used by two squadrons in Bomber Command - 617 (Avro Vulcan B2) and 139 (Handley Page Victor B2.

Avro Shackleton MR.2, WR960/X, of 228 Squadron, RAF Coastal Command, in flight near its base at St Eval, Cornwall.

The crew of a Valiant bomber 'scramble!' during a visit to Wyton by HRH the Duke of Edinburgh, 24 June 1958.

Vulcan bombers from RAF Waddington flying in formation in 1957.

A 2,100lb US Mk 43 nuclear weapon mounted on a SA trolley.

Handley Page Victor B1, XH615, of 232 Operational Conversion Unit in flight from its base at Gaydon, Warwickshire, in 1960.

Avro Vulcan B.2, XH537, carrying a pair of dummy Skybolt missiles on underwing pylons. Trials with the missile had started at Avro's Weapons Research Division at Woodford, Cheshire, in November 1961 following an Anglo/American agreement for the supply of up to 100 of the air-launched nuclear missiles which had been proposed as a way of extending the airborne nuclear deterrent into the next decade.